इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 1448-46 (1962): Methods of Test for Petroleum and its Products, Part 46: Knock Characteristics of Aviation Fuels by the Supercharge Method [PCD 1: Methods of Measurement and Test for Petroleum, Petroleum Products and Lubricants]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN
IGNORANTIA JURIS NON EXCUSAT
PROTECTED BY COPYRIGHT

(Reaffirmed 2003)

KNOCK CHARACTERISTICS OF AVIATION FUELS BY THE SUPERCHARGE METHOD

(P: 46)

Adapted from ASTM Designation: D 909-58*T*

1. SCOPE

1.1 This method describes the test for determining the knock-limited power, under supercharge rich-mixture conditions, of fuels for use in spark-ignition aircraft engines. By operational considerations, this method is restricted to testing fuels of 85 supercharge octane number and over.

2. TERMINOLOGY

2.0 For the purpose of this method, the following definitions shall apply.

2.1 Supercharge Octane Number Below 100 — The whole number nearest the percentage by volume of *iso*-octane (2, 2, 4-trimethylpentane) in a blend with *n*-heptane that matches the knock characteristics of the fuel when compared by this method.

2.1.1 By definition the supercharge octane number of *iso*-octane is 100 and that of *n*-heptane is 0.

2.2 Supercharge Rating Above 100 — The number of millilitre of tetraethyl lead (TEL) per 3·78 litre in *iso*-octane.

2.2.1 Supercharge ratings are normally expressed as octane numbers, below 100 and as performance numbers above 100. At 100, a rating may be expressed either as 100 octane number or as 100 performance number.

NOTE 1 — Because the octane number scale ends at 100, another arbitrary scale of values called performance numbers has been adopted for designating grades of aviation gasoline above 100 octane number. This scale was derived empirically in such manner that the performance number of an aviation fuel might represent approximately its maximum knock-free power output, expressed as a percentage of the maximum knock-free power output of *iso*-octane under comparable operating conditions. This scale is used in all specifications for expressing antiknock performance of aviation fuels with ratings above 100 octane number.

Thus a rich-mixture rating of 130 performance number in a given engine means that the fuel is capable of delivering approximately 130 percent of the knock-limited power obtainable with *iso*-octane under take-off conditions, provided the engine is designed for its utilization. Likewise, a lean-mixture rating of 115 performance number denotes that the fuel is capable of delivering approximately 115 per cent of the power obtainable with *iso*-octane when both are knock-limited under cruising conditions, provided the engine is designed for its utilization.

2.2.2 Sometimes it is desirable to convert the octane number to performance number. This can be done by using Table I and Table II of **P: 45**.

3. OUTLINE OF THE METHOD

3.1 The supercharge octane or performance number of a fuel is determined by comparing its knock-limited power with those for bracketing blends of reference fuels under standard operating conditions. This is done at constant compression ratio by varying the manifold pressure and fuel flow rate, the independent variables of the test, and measuring indicated mean effective pressure (imep) at enough points to define the mixture response curves for the sample and the reference fuels. When the knock-limited power for the sample is bracketed between those for two adjacent reference fuels suitably chosen from the prescribed list (*see* **10.1.2**), the rating of the fuel is calculated by interpolation at the fuel-air ratio for maximum power for the lower bracketing reference fuel.

4. APPARATUS

4.1 The knock testing unit consists of a single cylinder engine with accessories mounted on a stationary base. It is equipped with controls for varying manifold pressure, fuel flow, and loading. Suitable instruments are provided for the measurement of these variables.

NOTE 2 — Further details about the testing unit, its installation, maintenance, etc, will be covered in Indian Standard Manual, of which the details may be taken from the latest issue of ASTM Manual for Rating Aviation Fuels by Supercharge and Aviation Methods.

5. REFERENCE MATERIALS

5.0 The following reference materials are required.

5.1 *Iso*-**octane** (**2, 2, 4-trimethyl pentane**) — This fuel in the pure state has, by definition, an octane number of 100.

5.2 *n*-**Heptane** — This is a low antiknock fuel, which in its pure state has, by definition, an octane number of 0.

5.3 Reference Blends — These will be prepared from *iso*-octane and *n*-heptane specified in **5.1** and **5.2** respectively, after blending them in the requisite proportions. If, for example, an 80 octane number reference blend is required this will be prepared by mixing *iso*-octane and *n*-heptane in the volumetric proportion of 80 to 20.

5.4 Tetraethyl Lead — It is blended with *iso*-octane for making ratings over 100 octane number.

5.5 Benzene — conforming to requirements prescribed in **5.5** of **P: 45**, is required for blending with reference fuels to check rating characteristics.

6. OPERATING CONDITIONS

6.1 The following standard operating conditions are mandatory.

6.1.1 *Engine Speed* — 1 800±45 rpm including friction measurement. The maximum variation throughout a test shall not exceed 45 rpm, exclusive of friction measurement.

6.1.2 *Compression Ratio* — 7·0 to 1, fixed by adjustment of the clearance volume to 108·0±0·5 ml on cylinders of standard bore by the bench tilt procedure, described in the Manual (*see* Note 2). Clearance volumes for oversize cylinders are shown in the Manual. If the detonation meter pick-up is used, the clearance volumes are 2 ml less than for the Waukesha plug.

6.1.3 *Spark Advance* — constant, 45°±1°.

6.1.4 *Spark-Plug Gap* — 0·508±0·076 mm (or 0·020±0·003 in.).

6.1.5 *Breaker-Point Gap* — 0·380 mm (or 0·015 in.).

6.1.6 *Valve Clearances* — 0·203±0·025 mm (or 0·008±0·001 in.) for the intake; 0·254±0·025 mm (or 0·010±0·001 in.) for the exhaust. Both the measurements shall be done with the engine hot and running at equilibrium under standard operating conditions on a reference fuel of 100 octane number at the fuel-air ratio for maximum power and an absolute manifold pressure of 762 mm of mercury.

6.1.7 *Crankcase Lubricating Oil* — SAE 50, having a kinematic viscosity range of 16·8 to 22·8 cS at 99°C (or 210°F).

6.1.8 *Oil Pressure* — 4·2±0·4 kg/cm^2 (or 60±5 lb/in.^{2}) in the oil gallery leading to the crankshaft bearings.

6.1.9 *Oil Temperature* — 74°±3°C (or 165°±5°F) at the entrance of the oil gallery.

6.1.10 *Coolant Temperature* — 191°±3°C (or 375°±5°F) in the top of the coolant return line from the condenser to the cylinder.

6.1.11 *Fuel-Pump Pressure* — 1·1±0·1 kg/cm^2 (or 15±2 lb/in.^{2}) in the gallery.

6.1.12 *Fuel-Injector Opening Pressure* — 84·36±7·03 kg/cm^2 (or 1 200±100 lb/in.^{2}) for Bosch nozzle; 101·94±3·52 kg/cm^2 (or 1 450±50 lb/in.^{2}) for Ex-Cell-O nozzle.

6.1.13 *Fuel-Injector Timing* — The pump plunger shall close the fuel inlet port at 50°±5° (after top dead centre) on the intake stroke.

6.1.14 *Air Pressure* — 3·82±0·04 kg/cm^2 (or 54·4±0·5 lb/in.^{2}) absolute at the upstream flange tap of the air-flow meter.

6.1.15 *Air Temperature* — 52°±3°C (or 125°±5°F) in the downstream leg of the air-flow meter and 107°±3°C in the intake manifold surge tank.

6.1.16 *Intake Air Humidity* — a maximum of 10 mg of water vapour per gram (or 70 grains of water per pound) of dry air.

6.1.17 *Standard Knock Intensity* — light knock as determined by ear. In determining the light-knock point, it is advisable to adjust first to a fairly heavy knock by varying either the manifold pressure or the fuel flow, return to knock-free operation and finally adjust to the light-knock conditions. Light-knock intensity is a level definitely above the commonly defined least audible 'trace knock'; it is the least knock that the operator can definitely and repeatedly recognize by ear. Knock intensity indicators as described in the Manual (*see* Note 2) may be used as an aid to the ear in obtaining standard knock intensity.

6.1.18 *Satisfactory Engine Condition* — The engine should cease firing instantly when the ignition is turned off. If it does not, operating conditions are unsatisfactory. Examine the engine for defects, particularly for combustion chamber and spark plug deposits, and remedy such conditions before rating the fuels.

7. STARTING AND STOPPING THE ENGINE

7.1 Starting the Engine — While the engine is being motored by the dynamometer, turn on the ignition, then start fuel injection and adjust the fuel-air ratio for maximum power by means of the fuel control knob.

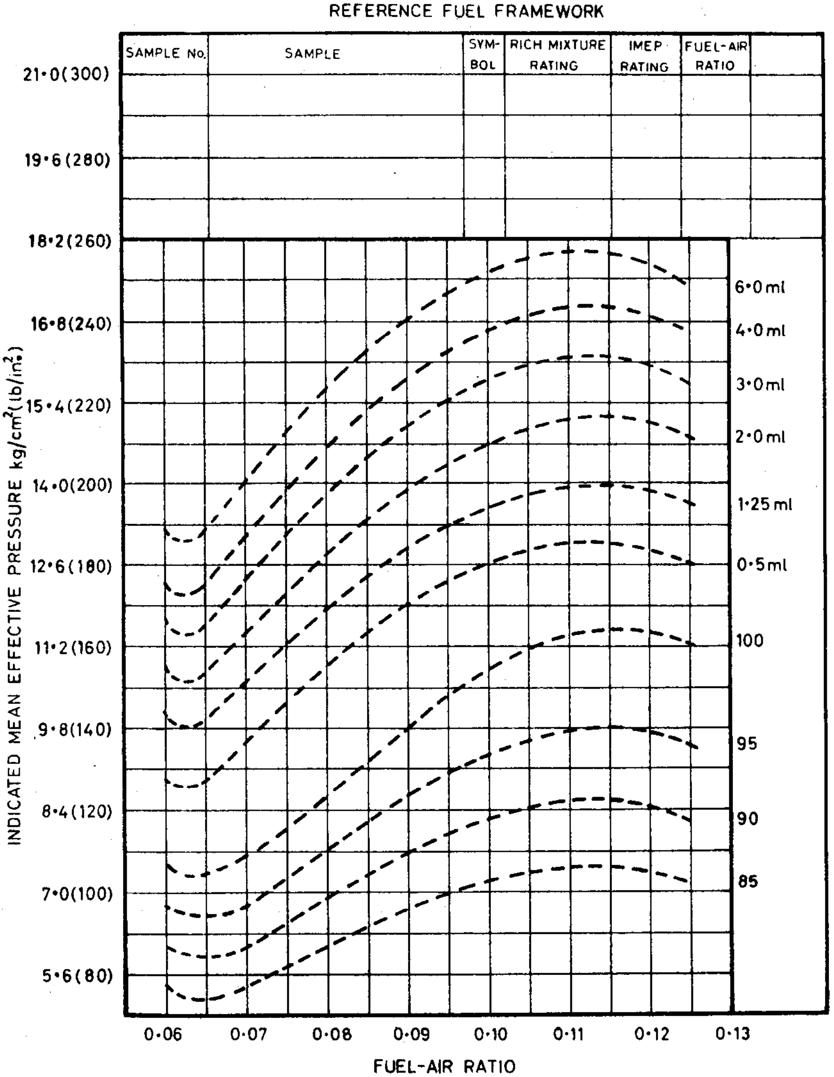
7.2 Stopping the Engine — Avoid valve warpage and unnecessary heat stress by operating the engine on unleaded fuel for several minutes at atmospheric manifold pressure or below. Prevent excessive washing of the cylinder walls by stopping the fuel injection before turning off the ignition. To avoid possible corrosion close both valves by turning the flywheel to top dead centre on the compression stroke.

8. STANDARD ENGINE PERFORMANCE

8.1 With the operating conditions (*see* **6**) established, it is necessary that the engine performance falls within the limits prescribed in **8.2** and **8.3**. Unless the power curve and the mixture response curves for the reference fuels conform to these limits, the test unit is unsatisfactory for rating the fuels and corrective steps are necessary.

8.2 The power curve for *iso*-octane plus 6 ml of tetraethyl lead per 3·78 litre of fuel shall show a peak of 164·5 ± 3·0 indicated mean effective pressure by varying the fuel flow and using standard operating conditions at a constant manifold pressure of 1 016 mm of mercury absolute.

8.3 Knock-Limited Power Curves — Between 0·08 and 0·12 fuel-air ratio, the knock-limited power curves for the reference fuel blends shall conform within ±5 percent to those shown in reference fuel framework (*see* Fig. 1). This framework has been established for supercharge knock test units operating under properly standardized conditions. The spread between any two adjacent reference fuel curves as determined with the engine shall agree with the spread of the corresponding framework curves within ±30 percent of the latter value.



SAMPLE No.	SAMPLE	SYMBOL	RICH MIXTURE RATING	IMEP RATING	FUEL-AIR RATIO	

ENGINE No. _ _ _ _ _ _ _ OPERATOR _ _ _ _ _ _ _ _ _ _

DATA SHEET No. _ _ _ _ DATE _ _ _ _ FRAMEWORK No. _ _ _ _ _ _ _

Fig. 1 Reference Fuel Framework

9. DETERMINATION OF KNOCK-LIMITED INDICATED MEAN EFFECTIVE PRESSURE (IMEP)

9.1 Obtain the knock-limited imep of a fuel at any test point by operating the engine at the fuel-air ratio and manifold pressure required for standard knock intensity.

9.2 Stabilization of Conditions — After standard knock intensity has been obtained, it is necessary to stabilize engine temperatures. During this period minor adjustments of the manifold pressure and fuel flow may be required to maintain standard knock intensity.

9.3 Observations — When the conditions have been stabilized, record observations for determination of test results and control of engine operation. Brake and friction torques, and fuel and air-flow rates are required for fuel ratings; coolant, oil and air-intake temperatures, and oil and absolute manifold pressures are desirable as indications of operating conditions. To ensure that the test points are adequately defining the knock-limited power curve, plot the curve as the points are determined.

9.4 Power Determination — Engine power output is expressed as imep, which is defined as the sum of the brake and friction measurements. Determine brake torques at the stabilized knock condition from the scale reading of the power absorbing unit, and express it as brake mean effective pressure (bmep). Determine the torque required to motor the engine from the scale reading of the power absorbing unit after each brake torque determination by quickly stopping the fuel injection and motoring the engine. Read the friction torque within 10 sec after stopping the fuel injection and express it as friction mean effective pressure (fmep).

9.5 Fuel-Air Ratio — The ratio of the weights of fuel and air supplied to the engine during equal operating intervals is the fuel-air ratio. With the engine operating under the stabilized knock conditions, determine the fuel and air-flow rates by observing the respective measuring devices. In practice, the air and fuel-flow rates are recorded as minutes per 113 g (or 0·25 lb) of air and minutes per 113 g (or 0·25 lb) of fuel, thus allowing the calculation of fuel-air ratio directly from the data.

10. RATING A SAMPLE

10.1 Obtain knock-limited power curves for the sample and two bracketing reference fuels as follows.

10.1.1 *Knock-Limited Power Curve for Sample* — Determine the knock-limited power curve for the sample from a series of knock-limited imep points established by the procedure and accompanied by the control observation outlined in **9.3.** This curve corresponds to that of Fig. 2 determined by points 1 to 6. The knock-limited imep points should be distributed throughout a fuel-air ratio range from approximately 0·08 to 0·12 to define the knock-limited power curve. The following plan of testing, with the points determined in the order mentioned, has been found satisfactory:

a) *Determine the first point* on the knock-limited power curve at approximately 0·08 fuel-air ratio by adjusting the mixture control of the fuel pump at an arbitrarily selected manifold pressure until the maximum brake torque is obtained. If knock occurs, reduce the manifold pressure and continue the adjustment of the fuel pump until a maximum brake torque is obtained without knock. Maintaining this setting, increase the manifold pressure until standard knock is obtained, checking as required in **6.1.17**. When equilibrium has been reached, record the observations.

b) *To determine additional points*, adjust the mixture control of the fuel pump to enrich the mixture and increase the manifold pressure by arbitrary increments (*see* Fig. 2, points 2 and 3). Following each change, slowly adjust the mixture until standard knock intensity is obtained, checking as required in **6.1.17**. When equilibrium has been reached, record the observations. Near the peak of the knock-limited power curve (*see* Fig 2, points 4, 5, and 6), it is more convenient to change the mixture control of the fuel pump by arbitrary increments and adjust the manifold pressure for standard knock intensity. When equilibrium has been reached, record the observations. At very rich mixtures make certain that the engine is firing regularly. At least six points are required to define the knock-limited power curve. Four should be on the rising portion of the curve and two at richer mixtures to determine accurately the maximum imep and the fuel-air ratio at which it occurs.

10.1.2 *Knock-Limited Power Curves for Reference Fuels* — Immediately bracket the knock-limited power curve of the test sample by determining those for two adjacent blends of reference fuels selected from the following list:

Iso-octane, percent by volume	*n-Heptane*, percent by volume	*Tetraethyl Lead in Iso-octane*, ml per 3·78 litre
85	15	—
90	10	—
95	5	—
100	—	—
100	—	0·5
100	—	1·25
100	—	2·0
100	—	3·0
100	—	4·0
100	—	6·0

Only these blends, prepared from the knock-test reference fuels (*see* **5**) may be used. The tetraethyl lead content may be determined by (**P: 37**) or (**P: 38**) of IS: 1448 (Part I)-1960.

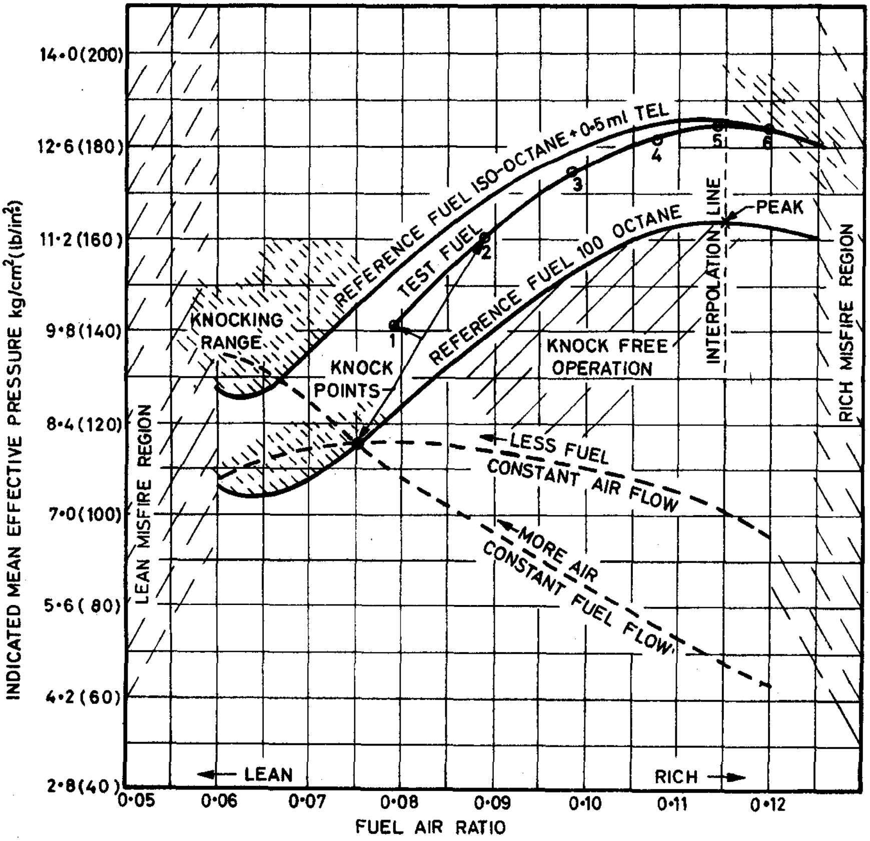


FIG. 2 DEVELOPMENT OF KNOCK-LIMITED POWER CURVES

11. TESTS TO SPECIFIED RATING

11.1 If a sample is being tested to ascertain whether it is equal to or better than a reference fuel, determine the knock-limited power curves of both fuels in accordance with the procedure outlined in **10.1.1** and plot them in the form of a graph such as that illustrated by Fig. 2. The sample passes the test if its knock-limited imep is equal to or greater than that of the reference fuel at the fuel-air ratio giving maximum knock-limited imep for the reference fuel.

12. REPORTING

12.1 Plot the knock-limited power curves for the sample and the bracketing reference fuels as a graph with fuel-air ratio as the abscissa and knock-limited imep as ordinate (*see* Fig. 1). The rating of the sample at any fuel-air ratio is that of the reference fuel which would result in the same imep when the engine is operated at standard knock intensity at the same fuel-air ratio as the sample. Determine the supercharge rating of the sample by linear interpolation between the knock-limited imep values for the sample and the bracketing reference fuel at the fuel-air ratio for the maximum knock-limited imep of the lower bracketing reference fuel. When the curve for the sample is above that for the upper bracketing reference fuel at the fuel-air ratio for the peak of the lower bracketing reference fuel, make the interpolation by using the imep at the intersection of the curve for the sample and a straight line connecting the peaks of the bracketing reference fuel curves.

12.2 Report ratings below 100 octane number to the nearest integer. When the interpolated figure ends with 0·50, round off to the nearest even number; report for example, 91·50 as 92 not 91 (*see also* IS: 2-1960).

12.3 Report ratings above 100 octane number in concentrations of TEL per 3·78 litre of *iso*-octane; to the nearest 0·05 ml below 1·0 ml, to the nearest 0·1 ml from 1·0 ml to 3·0 ml and to the nearest 0·25 ml for 3·0 ml or more.

13. REPRODUCIBILITY

13.1 Although different scales are used for ratings by this method, the performance numbers listed in Table I and Table II of **P: 45** provide a common scale for determining reproducibility below and above 100 octane number.

13.2 Extensive data from independent laboratories over a number of years for many samples of conventional aviation gasolines have shown a standard deviation of 2·0 performance number (an average deviation of about 1·5 performance number). Based on this standard deviation, the number of tests required to yield a rating of desired accuracy is given below:

ACCURACY DESIRED, PERFORMANCE NUMBER	NUMBER OF TESTS REQUIRED TO OBTAIN THE DESIRED ACCURACY		
Plus or Minus	9 times out of 10	19 times out of 20	99 times out of 100
4	1	1	2
2	3	4	7
1	11	15	27

The above table shows that it is normally necessary to obtain two ratings to be within ±4 performance number of the true value in about 99 cases out of 100. On the other hand, if an accuracy of ±1 performance number is desired with certainty of 90 percent (9 times out of 10) it is necessary to obtain an average of eleven ratings in eleven different engines (preferably in eleven independent laboratories). Although the degree of reproducibility applies to conventional aviation gasolines when careful attention is given to the details of test procedure and engine condition, it does not necessarily apply to fuels which differ materially from finished aviation gasolines. With such fuels the reproducibility is likely to be lower and result in higher standard deviations.